

## WEATHER ON THE NORTH PACIFIC OCEAN

By WILLIS E. HURD

**Atmospheric pressure.**—On an average, there were two great centers of pressure activity on the North Pacific Ocean during April 1941. The more important feature was the abnormally deep Aleutian low which, fed by a succession of higher latitude cyclonic depressions, attained an average depth of 996.8 millibars (29.44 inches), at Dutch Harbor. This value is 11.7 millibars (0.34 inch) below the normal of the month. Pressure was very low as far east as Kodiak, but from Juneau southward to Mazatlan, barometer means were only slightly below normal. In waters off central California, owing to the movements of several disturbances, pressure was moderately low for the month, the average at San Francisco being 3.0 millibars (0.09 inch) below the normal. The North Pacific anticyclone was central in the general vicinity of Midway Island, where the mean barometer, 1,021.9 millibars (30.18 inches), was 1.9 millibars (0.06 inch) above the normal. In the extreme southwestern part of the ocean, the spring condition of low pressure, following the warming up of the adjacent land surface, was beginning to appear.

TABLE 1.—Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Pacific Ocean and its shores, April 1941.

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	Millibars	Millibars		Millibars	
Barrow	1,020.4	+1.8	1,039	18	1,009	7
Dutch Harbor	996.8	-11.7	1,022	17	975	11
St. Paul	1,000.5	-8.3	1,025	17	984	22
Kodiak	998.7	-8.8	1,018	17	982	7
Juneau	1,012.5	-2.1	1,033	16	995	4
Tatoosh Island	1,015.2	-0.7	1,026	17	994	4
San Francisco	1,014.6	-3.0	1,025	16	998	10
Mazatlan	1,011.4	-0.8	1,013	1, 7, 15, 16, 26	1,008	24
Honolulu	1,017.6	-0.4	1,024	1	1,012	22
Midway Island	1,021.9	+1.9	1,027	6	1,015	22
Guam	1,011.1	-1.1	1,015	3, 7	1,009	17, 25, 26
Manila	1,009.8	0.0	1,014	1, 8	1,008	14, 15, 19, 24, 26
Hong Kong	1,012.2	+0.3	1,022	6	1,005	25
Naha	1,014.6	+1.4	1,024	7, 8	1,009	20
Titijima	1,016.0	+1.1	1,025	3	1,007	23
Petropavlovsk	1,009.9	+0.8	1,027	19	986	4

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

**Cyclones and gales.**—At the close of March a disturbance of some intensity was causing stormy weather over the eastern third of the California-Hawaiian routes. On the 1st and 2d of April the disturbance moved northward with lessened intensity, and a cyclone from the Aleutian region, traveling rapidly in a general southeasterly direction, lay on the 3d and 4th off the northwest coast of the United States. As a result of the two lows, fresh to strong westerly to southerly gales were experienced by coastwise steamers off Oregon and southern Washington during the 2d to 4th, while farther southwestward, between California and the Hawaiian Islands, westerly winds of force 8 occurred on the 3d and 4th. The strongest wind due to the storm was a west gale of force 11 experienced during the early morning of the 3d, near 38° N., 149° W.

On April 9 a further cyclone appeared to the westward of Oregon, causing local gales, with the highest reported of force 9, near 43° N., 135° W. The storm lay close off the coast on the 10th. The highest wind observed in connection with it on that date was of force 10, reported by the American S. S. *Manulani*, in 36°30' N., 126°42' W. On the 11th the cyclone entered California, but as late as the morning of the 12th strong winds occurred along the

coast, the American S. S. *Matsonia* reporting a northwesterly gale of force 9 a few hours out from San Francisco.

On the 15th to 18th strong winds, at times attaining gale strength, again disturbed our west coast. Off northwestern Washington the higher winds, of force 8, were from the west, but off the middle California coast, they were northwest to north. The strongest wind reported at sea was from the north, of force 9, experienced on the 16th by the American S. S. *Makua*, in 37°30' N., 123°48' W. These winds occurred on the eastern slope of the oceanic high, then abutting upon the continent.

In middle Pacific longitudes known gales were few. The stormiest period was about the 8th to 10th, with gales, apparently localized, rising at times to force 10. On the 10th and 11th a cyclone of considerable depth extended from the Bering Sea to the southward of the 40th parallel, and on the 10th the U. S. A. T. *Meigs* had a west gale of force 10 and the lowest barometer reading reported for the month, 971.9 millibars (28.70 inches), near 41° N., 175° E. Much farther eastward on that day the American M. S. *West Cusseta* had a southwesterly gale of force 10, connected with the same storm, near 50° N., 155° W.

Early in the voyage of the M. S. *West Cusseta* from the Orient toward Vancouver, on April 3, the vessel entered a cyclone to the eastward of the Kuril Islands. From about 6 p. m. of the 3d to about 8 a. m. of the 4th, and beginning near 45° N., 163° E., she was under the influence of northwesterly winds of force 11, lowest barometer 983.7 millibars (29.05 inches). This condition of storminess was by far the most important reported by ships during the month from the extreme western part of the ocean.

**Fog.**—Very few reports of fog were received. Among the most interesting was one from a vessel that encountered fog on the 21st northeast of the Ogasawara (Bonin) Islands and did not entirely leave the fog area until the 24th, near 36° N., 161° E. On the 28th fog was observed near 40° N., 170° W., and on the 8th to 13th, over a region extending southwestward from about 40° N., at 133° W., to 33° N., at 157° W. The occurrences were on the 8th to 10th on the western half of the region, and on the 11th to 13th, on the eastern half. The only near-coastal fog reported was on the 27th, west of Washington.

## RIVER STAGES AND FLOODS

By BENNETT SWENSON

The precipitation pattern during April followed quite closely the trend of previous months, the eastern part of the country and the far northwest being quite dry while from the central Mississippi Valley westward and southwestward precipitation was generally above normal. Temperatures were well above normal over all sections except the far southwest.

Excessive rains occurred in Arkansas, southwestern Missouri, southeastern Kansas, and eastern Oklahoma during the middle of April. Flooding was severe locally in this area and in the main reaches of the Osage, Gasconade, and Neosho Rivers. Six lives were reported lost due to flooding in the Ozarks region. Floods of less severity were experienced in the lower reaches of the Missouri and Arkansas Rivers, and in the White River.

River stages were high in the upper Mississippi River with flooding in northern Minnesota and stages slightly above flood stage in the Mississippi River from Keokuk, Iowa, to Louisiana, Mo. Slight flooding occurred in some of the streams in the eastern Carolinas. Stages continued high in Texas, the Southwest, and in the Sacramento Basin with some flooding.

Stages were still unusually low in most of the Ohio Basin but some rains occurred during the month and slight flooding was reported in parts of Tennessee and Kentucky.

*Atlantic Slope drainage.*—The volume of spring run-off in most of New England was unusually small. A long period of clear weather with low humidity and scanty precipitation, accompanying the persistence of polar air masses over that area, resulted in a rapid depletion of the snow cover by evaporation. Also, the early season snow cover prevented the usual depth of frost penetration and caused considerable early losses of snow to ground water.

At Concord, N. H., the precipitation for the period March 12 to April 17, when the peak stage in the Merrimack River occurred, totalled only 0.52 inch. The greatest 24-hour rainfall during this period was 0.24 inch on March 17. The highest stage at Concord was 6.5 feet (flood stage 12 feet) on April 17.

A slow and steady rise began in the Connecticut River early in April and continued at Hartford, Conn., until the 17th, the rise being due entirely to melting snow. Flood stage was exceeded only at South Newbury, Vt., from the 16th to the 20th where a stage of 20.8 was reached on April 18.

A moderate rise occurred gradually during the first week in April in the Delaware River due to the run-off from melting snow aided by a moderately heavy rain on the 5th–6th. Flood stages were not reached and by the close of the month stages had receded to below normal for the season.

Heavy rain over the upper Susquehanna River Basin on April 5 brought rising stages to above flood stage on the 6th and 7th. The stages had been rising from the melting of considerable snow in the wooded areas and on northern slopes. Flood stages were reached or slightly exceeded in all of the upper basin down to and including Wilkes-Barre, Pa., where a stage of 23.9 feet (flood stage 22 feet) was reached on April 7, but no appreciable damage occurred.

Moderate rises occurred in the Potomac and James Rivers from rains on April 5 but the only station to reach or exceed flood stage was Columbia, Va., on the James River, where a peak stage of 17.2 feet occurred on April 6. One or two stations on each of the Roanoke, Neuse, Cape Fear, Pee Dee, and Savannah Rivers reported stages above flood during this period but no damage resulted.

*East Gulf of Mexico drainage.*—In the Pearl River Basin a period of moderate rainfall during the first few days of April resulted in only moderate rises, while another period of moderate to heavy rainfall, occurring from the 20th–24th, resulted in minor flooding in the lower Pearl.

*Upper Mississippi Basin.*—Melting of snow coupled with moderate rains early in April in the extreme upper Mississippi Basin caused moderately high river stages in the Minneapolis-St. Paul area and flooding in the headwaters of the Mississippi River. A crest of 13.2 feet occurred at Minneapolis (flood stage 16 feet) on the 11th and 11.5 feet at St. Paul (flood stage 14 feet) on the 12th. The river, meanwhile, continued to rise in the upper reaches, aided by an extended period of rainfall from April 13–19, cresting at a stage of 14.7 feet at Aitken, Minn. (flood stage 12 feet), on April 22–23 and 10.1 feet at Fort Ripley, Minn. (flood stage 10 feet), on April 20. The peak stages from this rise were 13.3 feet at Minneapolis

on April 22 and 11.0 feet at St. Paul on April 24. The maximum flow at La Crosse, Wis., at the peak stage of 10.9 feet was 81,600 second-feet on April 18.

Losses from the floods in this area were not great because no crops had been planted. Farm property losses above Minneapolis were estimated at \$10,000 and losses in Aitken County to roads and bridges were estimated at \$38,000. There was some flooding of the lowlands along the Mississippi from Red Wing, Minn., to La Crosse, Wis., with reported losses amounting to \$13,000 in that area. Slight damages were caused in the Chippewa River and other tributaries in west central Wisconsin and southeastern Minnesota from high water in those streams.

Flood stage was exceeded in the main channel of the Mississippi also in the reach between Keokuk, Iowa, and Louisiana, Mo., from April 19 to the end of the month. No appreciable damage resulted.

Flooding occurred in the Bourbeuse and the Meramec Rivers in Missouri, draining into the Mississippi River below St. Louis, Mo. A discussion of this flooding will be given below in connection with rather severe floods which occurred in the Osage and Neosho Rivers.

*Missouri, Arkansas, and White Basins.*—A large anticyclone was centered over or slightly east of Florida from April 14 to 20 and resulted in a strong flow of warm moist tropical air northward over eastern Texas and eastern Oklahoma and thence northeastward over Missouri. Heavy rainfall occurred over Arkansas, eastern Oklahoma, southeastern Kansas, and southern and eastern Missouri. The amounts were exceedingly heavy over southwestern Missouri and adjoining sections of Oklahoma, Kansas, and Arkansas.

Floods were especially severe in the Osage, Gasconade, and Neosho Rivers where record or near record breaking stages occurred. Overflows occurred also in the Meramec, Bourbeuse, Cimarron, Verdigris, North Canadian, Poteau, White (in Arkansas), and lower Missouri and Arkansas Rivers but were less severe.

Stormy conditions, attended by heavy rains in southwest Missouri from the 14th to the 19th caused considerable damage to soil by overflow of creeks and other small streams, and resulted in six deaths. Only two deaths were due entirely to wind, and these in connection with a small tornado during the late evening of the 18th near Reeds Spring. Practically every small stream in southwest Missouri overflowed, and press reports indicate damages of somewhat more than a million dollars. The greatest damage was evidently to the secondary road systems operated by the counties and to farm lands that were badly eroded by the excessive rains. The water plant at Joplin was forced to close down by the flood, and heavy damage was suffered at Monett by the flooding of stores. Houses and mines in the Webb City-Oronogo district were overflowed and rendered useless, and much livestock was swept away. No estimates of damage include losses of private property owners, which undoubtedly was high; and the total damage over southwest Missouri must have been well over a million dollars.

The average amounts of precipitation over some of the drainage areas in Missouri for the 6-day period ending April 20, were as follows: Osage, 5.9 inches; Gasconade, 4.85 inches; Meramec, 4.1 inches; and lower Missouri, 4.4 inches.

In the Verdigris River Basin, rainfall amounts from April 13 to 19 ranged from 3.33 inches at Toronto, Kans., to 8.24 inches at Claremore, Okla. Precipitation over the Grand Lake area in Oklahoma from April 14 to 19, ranged from 7.62 inches at Jay to 10.44 inches at Spavinaw, while below Pensacola Dam stations reported amounts ranging from 2.51 inches at Sallisaw, Okla., to 10.4 inches at Pryor, Okla.

The crest stages for a few stations compared with the previous highest stages of record are as follows:

River and station	Flood stage	April 1941		Previous high	
		Crest	Date	Stage	Date
Bourbeuse River: Union, Mo.....	Feet 12	Feet 17.0	21	Feet 19.2	October 1919.
Meramec River:					
Sullivan, Mo.....	11	16.3	20	15.7	May 1937.
Pacific, Mo.....	11	20.0	22	30.8	August 1915.
Valley Park, Mo.....	14	21.6	23	30.7	October 1919.
Gasconade River: Jerome, Mo.....	15	22.3	21	28.6	August 1915.
Osage River:					
Osceola, Mo.....	20	29.8	21		
Lakeside, Mo.....	60	61.7	20	61.0	June 1937
St. Thomas, Mo.....	23	32.3	22	32.9	June 1935.
Verdigris River: Sageeyah, Okla.....	35	40.4	22	40.4	April 1929.
Neosho River:					
Parsons, Kans.....	22	24.8	17		
Oswego, Kans.....	17	22.3	17	25.4	April 1927.
Wyandotte, Okla.....	23	36.4	20	30.0	April 1912.
Fort Gibson, Okla.....	22	33.5	21	35.0	May 1908.
Arkansas River:					
Webbers Falls, Okla.....	23	31.3	21	33.6	April 1927.
Fort Smith, Ark.....	22	31.4	22	36.7	Do.

**Red Basin.**—The Red River at Fulton, Ark., and the Little and Sulphur Rivers draining into the Red River in that area exceeded flood stages near the close of the month. There had been frequent flooding in this section during the past few months and no further appreciable damage was caused during April.

The heavy rains in Arkansas during the month resulted in a rise in the upper Ouachita River causing some flooding in the vicinity of Camden, Ark. Damages amounting to \$11,000, mostly to prospective crops, were reported.

**West Gulf of Mexico drainage.**—The Trinity River overflowed its banks at Dallas, Tex., twice during the month, reaching the same crest stage (30.7 feet) on both April 20 and 24. The overflow at Dallas was not serious, but at Trinidad, Tex., several hundred acres of bottom land were flooded. Livestock were removed on the basis of flood warnings.

A flash flood occurred on the Bosque River at Hico, Tex., on April 17 and 18, causing damage amounting to about \$4,500.

The Guadalupe and Nueces Rivers were above flood stage at the end of the month. A report will be made on these floods in the next issue of the REVIEW.

Excessive rains caused the Pecos River to reach flood stage at Artesia, N. Mex., on April 29. Some lowlands were flooded below Artesia but no damage of importance occurred. However, there was about \$5,000 damage to approaches to bridges by flash floods in tributary streams to the Pecos River in the vicinity of Roswell, N. Mex.

The Rio Grande had approached flood stage at Albuquerque, N. Mex., at the close of the month.

**Colorado River Basin.**—Heavy rain over the Verde River

Basin on April 11 produced some high water in the Verde and Salt Rivers. The flow in the Verde is controlled by Bartlett Dam and the peak stage in the Salt River was held to 4.8 feet at Phoenix, Ariz., on April 14. A radio range site located on low ground near the Salt River sustained considerable damage, the extent of which is not known at this time.

**Pacific Slope drainage.**—Owing to an abnormally wet winter season discharge in Tulare Lake drainage continued much above normal and surplus water not needed for irrigation continued to flow into the Tulare Lake Basin.

Rain was heavy over the upper Sacramento Basin on March 30, when 4.1 inches occurred at Vollmers, Calif. On April 4 excessive rain was again general with another 4.3 inches at Vollmers, and 3.96 inches at Kennett, Calif., in 24 hours.

The Sacramento River crested at Kennett at 19.7 feet and at Red Bluff, Calif., at 26.2 feet on April 4. These stages were higher than for previous floods this season. The Feather and American Rivers were only moderately high and no important rise occurred in the lower San Joaquin. Many of the local creeks caused overflow damage from the rains of April 4 which were especially heavy in the valley and the adjacent foothills.

At Knights Landing, Calif., with a crest stage of 30.9 feet on April 7, there was an overflow into Yolo Bypass. This overflow, together with a heavy discharge of Cache and Putah Creeks materially increased the volume of water in the bypass. This bypass and also Butte Basin and Sutter Bypass have been flooded since December 1940. In some of the areas the water had been pumped or drained out in March. The reflooding in April resulted in further delay in crop planting.

The total losses from the flooding during April have been estimated to be over \$250,000.

#### ESTIMATED FLOOD LOSSES AND SAVINGS FOR APRIL 1941

River and drainage	Tangible property	Matured crops	Prospective crops	Livestock and other movable farm property	Suspension of business	Total losses	Total reported savings
East Gulf of Mexico: Pearl River.....					\$1,000	\$1,000	\$1,000
Mississippi System—Upper Mississippi Basin:							
Chippewa River.....	\$1,000					1,000	
Upper Mississippi River.....	48,000		\$1,000	\$10,000	2,000	61,000	5,000
Missouri Basin: Lower Missouri River and tributaries <sup>1</sup> .....	100,000					100,000	3,500
Ohio Basin: Black and Orchard Creeks <sup>2</sup> .....	100		2,050			2,150	
White Basin: White River.....	3,200	800	38,200	400	10,000	52,600	15,000
Arkansas Basin:							
Neosho River in Kansas.....	15,000		1,600	200		16,800	
Marmaton River.....	1,500		1,600	3,000	1,000	7,100	
Lower Neosho and Arkansas Rivers.....	3,000	5,000	320,000	1,000	10,000	339,000	190,000
Streams in southwest Missouri.....						\$1,000,000	
Red Basin: Ouachita River.....	250		10,000	250	500	11,000	11,000
West Gulf of Mexico: Pecos River.....	5,000					5,000	
Pacific Slope: Sacramento River.....	141,300	10,600	110,000	1,000		262,900	5,000

<sup>1</sup> Mainly Osage River and lower Missouri River from Jefferson City to Hermann, Mo.

<sup>2</sup> Tributaries of Tennessee River in vicinity of Rockwood, Tenn.

<sup>3</sup> From Press reports; 6 lives lost.